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(54) PROCESS FOR PRODUCTION OF A SIMULATED MEAT PRODUCT

(71) We, THE QUAKER OATS COMPANY, a Corporation organised and existing under the laws of the State of New Jersey, United States of America of, 617 West Main Street, Barrington, Illinois, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a simulated meat product from concentrated proteinaceous material.

Many attempts have been made to produce simulated meat products from relatively inexpensive protein sources. Perhaps the most successful of these processes has been the so-called spun protein which utilizes small strands of protein bound together by a binder to simulate meat. Thus far, however, no one has produced a simulated meat product which has the taste and particularly the texture characteristics of natural meat. This invention makes possible a simulated meat product high in protein and having the same texture characteristics as natural meat.

It is an object of this invention to provide a process for preparing a puffed food product simulating meat and having the texture characteristics of meat.

It is another object of this invention to provide a process for utilizing relatively inexpensive proteinaceous materials to prepare a simulated meat product.

According to the present invention there is provided a process for preparing a puffed food product which upon rehydration produces a material simulating meat comprising: forming a proteinaceous mixture containing water, a protein material comprising a member selected from gelatin, microbiological protein, egg white, muscle protein, keratins, lactalbumin, or blood having a protein concentration of at least 30 per cent by weight and 1/2 to 3 parts by weight of an edible lubricant per 100 parts by weight of non-fat solids; subjecting the mixture to shear and/or elevated pressure and/or elevated temperature; extruding the flowable substance in a uniform linear flow into a medium of lower pressure to form an extrudate which does not simultaneously puff without texturization; placing the extrudate in a confined space; subjecting the extrudate in the confined space to a temperature of at least 212°F for a time of from 15 to 75 seconds and a pressure of from 150 psi to 250 psi; and suddenly releasing the pressure on the extrudate causing the extrudate to puff and resemble meat and form a puffed food product having a moisture content of from 15 to 40 percent by weight.

The protein concentration must be at least 30 percent by weight in order to provide a protein content sufficient to supply the dietary needs of a person consuming the product in lieu of meat or as a partial substitute therefor. The protein material of this invention can be gelatin, microbiological protein such as yeast and single cell protein, egg white, muscle protein, keratins such as hoofs, hair and feathers, lactalbumin, or blood, either whole or as blood meal.

The first step in this process requires the formation of a proteinaceous mixture by mixing protein material comprising a member selected from the group consisting of gelatin, microbiological protein, egg white, muscle protein, keratins, lactalbumin, or blood with water in an amount sufficient to provide a final moisture content in the finished product of from 15 percent to 40 percent by weight. The moisure can be readily adjusted within this range by one skilled in the art, but must be maintained within the range if later puffing is to produce a simulated meat product.

The first step of this process also includes the mixing of from 1/2 percent to 3 percent

by weight of an edible lubricant with the proteinaceous mixture of protein material prior to subjecting it to the next step shear, elevated pressure and/or elevated temperature. The edible lubricant can be any edible oil although it is strongly preferred to use a vegetable oil, such as corn oil, or coconut oil. In other words, the edible oil can be an animal oil or fat or a vegetable oil or mineral oil. In these cases, the edible lubricant is added in an amount of from 1/2 percent by weight to 3 percent by weight. The added lubricant can also be in the form of an oil bearing cereal product or oil bearing grain. In these cases, sufficient cereal product or grain must be added to bring the overall added lubricant content to from 1/2 percent by weight to 3 percent by weight. In other words, if the cereal product contains 50 percent by weight edible oil, then it should be added in an amount of from 1 percent by weight to 6 percent by weight to give the proper quantity of added edible lubricant. The added edible lubricant can also be in the form of an oil bearing animal product which also would be added in an amount sufficient to give an overall added oil content of from 1/2 percent by weight to 3 percent by weight. Thus, the added edible oil includes, but is not restricted to such things as oat flour, partially defatted soybean flour, full fat soybean flour, wheat germ, corn oil, vegetable oil, lard, corn germ, and edible mineral oils. It may also include such things as fatty acids produced by saponification of the required amount of edible oil or fat, an example being the well known food grade stearates or polylactic acid esters of fatty acids, e.g. sodium stearyl-2-lactylate. If the amount of lubricant goes below 1/2 percent by weight then the inprovements are not significantly realized. If the amount of lubricant exceeds 3 percent by weight then the product begins to crumble and does not have the texture and appearance of meat. The added oil increases production rate and thus minimizes heat and pressure exposure which lead to degradation of the product.

The next step in this process requires subjecting the mixture to shear and/or elevated pressure and/or elevated temperature to convert it into a flowable substance. This may be accomplished by many known methods including the common macaroni or spaghetti-type extruding operations.

The next step in the process requires extruding the flowable substance in a uniform linear flow into a medium of lower pressure to form an extrudate which does not simultaneously puff. In other words, this step requires extruding the moistened proteinaceous mixture into a lower pressure range without puffing it. By use of the term "puffing" at this point in the process, it is simply meant expansion or that expansion must be prevented. This consequently produces a glassy or glass-like surface on the outer portion of the extrudate. The extrudate has a translucent appearance and a laminar structure.

The next step in this process is preferred although not absolutely necessary and comprises partially reducing the moisture content of the issued extrudate without puffing (expanding) it. This can be accomplished by any of the known drying methods such as a hot air stream or a conventional or microwave oven. The critical feature of this step of our invention, when it is used however, is that the extrudate must be partially dried without causing puffing (expansion).

The next steps in our process require placing the extrudate in a confined space and subjecting the extrudate in the confined space to a water-boiling temperature (i.e., at least 212°F.) for a time of from 15 to 75 seconds and a pressure of from 150 psi to 250 psi. One skilled in the art can readily decide what pressure and time exposure is necessary in order to give the skilled person the simulated meat product that is desired.

Finally, the pressure is suddenly released on the extrudate causing the extrudate to puff (expand) and resemble simulated meat. The pressure releasing step can be accomplished merely by opening the confined space wherein the extrudate has been confined at a higher pressure. When the extrudate is puffed, it can be dried somewhat or merely left to dry from its own retained heat thus forming a simulated meat product. The product of this invention bears a particularly close resemblance to chicken meat having an exterior skin portion and a fibrous inner portion very much like cooked chicken meat.

The resulting puffed, proteinaceous food product can, if desired, be used as a food supplement for humans. The protein material comprising a member selected from the group consisting of gelatin, microbiological protein, egg white, muscle protein, keratins, lactalbumin, or blood may contain protein material which may or may not therefore be at least partly neutralized, or may or may not be reacted to an at least partly neutralized form. If desired the extrudate may be subdivided before puffing or the puffed product may be subdivided.

The structured or textured puffed product has good texture, water absorption or retention properties, and firmness in the essentially dry state and in water at room temperature, in boiling water, and when

retorted. The terms "textured" or "structured" hereinafter refer to puffed proteinaceous products which when hydrated have the feel, firmness, structure, texture or bite qualities similar to natural food products, for example meat, fish or poultry products, and puffed food products which are pleasing in the mouth of humans.

The protein materials which may be used in this process include the aforementioned protein materials having a protein content of at least 30 percent by weight or, preferably, a protein content of at least about 70 percent by weight. If desired, such protein materials may be treated (e.g., with acids, acid salts, alkali metals, or alkaline earth metal hydroxides) so that they have a pH within the range of 5.5 to 8.5.

As the pH of the protein material is lowered, there is a tendency for the puffed product to be somewhat tougher or have somewhat less of an ability to absorb or retain water.

When one wishes to produce a blank, puffed proteinaceous product, which for many purposes is preferred, the protein material whould be substantially or essentially pure and have a high protein content. If one wishes to produce a puffed, proteinaceous food product which need not be completely bland, one may use proteinaceous materials of lower protein content.

If desired, the proteinaceous material may include, for some purposes, a desired, edible amount (e.g., preferably less than 50 percent by weight) of a suitable cereal, starch, sugar, coloring material, seasoning or flavoring ingredient. These materials may be present in or blended with the proteinaceous material before elevated pressure is applied. One may use, for example, wheat flour, corn starch, yellow corn flour, cane sugar or dextrose.

Furthermore, it has been found desirable to include an edible form of available calcium (e.g., calcium ions) in or with the proteinaceous material, at the time that material is subjected to extruding conditions for purposes of imparting a sturdier structure (e.g., skeleton-like structure) to the puffed, textured, proteinaceous product so that the puffed product has a higher degree of firmness or chewiness when that product is in an essentially dry state that exists after puffing and when it is subjected to rehydration. Although calcium tends to enhance the rehydrated texture of the puffed product, good or satisfactory rehydrated firmness or chewiness can be obtained without it. The calcium may be incorporated into the proteinaceous material in the form of an edible calcium salt such as dicalcium phosphate dihydrate or calcium chloride, without imparting an undesired flavor to the puffed proteinaceous product.

The proteinaceous material is in a substantially uniform, moist (e.g., crumbly to free-flowing) state and has a controlled, effective amount of water when it is subjected to treatment to convert it to a flowable substance such as shear. The moist material must be subjected to treatment under conditions, which result in that material being transformed into a workable, substantially homogeneous, deformable, flowable, coherent plastic mass which forms a moisture-containing, translucent to glassy product that is not puffed as a result of that treatment and has thermoplastic characteristics. It is preferred that essentially all of the moist proteinaceous material be transformed into the translucent to glassy product. Furthermore, the translucent to glassy product must retain some of its moisture until the product is later puffed in a separate and distinct operation.

The amount of water and edible lubricant present during the treatment to produce a flowable substance, the nature of the proteinaceous material, the conditions of temperature, pressure and time used in connection with the compaction operation, the nature of the particular equipment used for applying shear, and the particular characteristics sought (e.g., fine or coarse cells or texture) as a result of the later, separate puffing step, are interrelated and should be coordinated. Thus, when one operating condition is varied or selected, that condition in turn can influence the other desired operating conditions.

It has been found, for example, that if too high a temperature is reached or applied during the treatment, material is subjected to too high a temperature during the formation of the translucent to glassy product, the proteinaceous material has a tendency to discolor or develop a flavor as a result thereof (characteristics which are undesired when a bland, natural-colored, puffed product is sought) even though the later produced puffed product has a greater tendency to be firmer in texture when it is rehydrated.

The use of too low a temperature during compaction can prevent one from producing the desired translucent to glassy product or later result in producing a poorly puffed product that is rather soft or mushy. It is, therefore, necessary that one apply shear in a manner which gives the desired texture without exposure to temperature and pressure conditions which degrade the material or cause loss in color and flavor.

The application of shear to the proteinaceous material tends to increase

the temperature of that material. When even below water-boiling temperatures accompany the application of mechanical pressure such conditions may yet be sufficient for the formation of the above referred to plastic mass and translucent to glassy product.

It may be necessary to apply external heat to the proteinaceous material so as to subject it to water-boiling temperatures during or in conjunction with the application of elevated pressure for the purpose of forming a plastic mass which is transformed into a translucent to glassy product, and in such instances the application of mechanical pressure should be conducted in a system (e.g., extruder) that is closed during operation so as to obviate the loss of moisture from the material or system. In order to avoid simultaneously puffing the compacted material (subjected to water-boiling temperature) when a flowable mass is discharged or ejected from the system into medium of lower pressure or unconfined zone at atmospheric pressure, it is necessary to cool the mass to below water-boiling temperatures before the material is discharged or ejected from the system.

The controlled amount or concentration of water and edible lubricant present in or with the proteinaceous material which is subjected to treatment to render it flowable such a shear and/or elevated pressure and requisite temperature conditions must be sufficient to facilitate converting that material into a plastic state which forms the translucent to glassy product.

The moisture content of the mixture, prior to the treatment to render it flowable, should be in the range of from 15 to 40 percent by weight.

When calcium is present with or in the protein material it may be desirable, for some purposes, to use a relatively high level of water (e.g., within the range of 35 to 40 percent) to increase the water absorption or water retention properties of the puffed product when it is rehydrated in boiling water.

A variety of devices may be used to increase shear. One may use, for example, a press, commercial rolls or pellet mill, or extruder which subjects the moist proteinaceous material to sufficient pressure and temperature and forms a product of desired size and shape (e.g., sheets, discs, pellets, rods, strings or bars). When an extruder is used, it is essential not to discharge or eject the extrudate under water-boiling conditions, so that extrusion does not subject the material to simultaneous puffing which normally results from the rapid or sudden release of water vapor from the mass when or as the discharged or ejected extrudate enters a zone of lower pressure. Thus, if such pressures or temperatures are developed prior to the discharge or ejection of the plastic material through the restricted extrusion die, nozzle or orifice which would cause the issuing or issued extrudate to rapidly release water and puff, it is critical to reduce the temperature of the plastic mass so that it is not discharged or ejected under water-boiling or puffing conditions. The pressure differential across the die, nozzle or orifice thus must not cause the extrudate to puff.

Although a variety of injection molding machines, and thermoplastic extrusion and compression molding machines may be used in the forming of the plastic mass, one can advantageously use a heatable extruder having a rotating compression or compaction screw within a closed heatable barrel and temperature controllable, restricted extrusion die, nozzle or orifice at the front end of the barrel. The barrel, in conjunction with the compression or compaction screw, creates, during operation, a closed chamber which prevents the release of existing water vapor from the material and system. The rotating screw builds up sufficient pressure to cause the plastic mass to be pushed at the desired temperature and pressure to and through a die, nozzle or orifice. It is critical that the compressed, flowable material not be discharged or ejected from the extruder under water-boiling i.e., puffing conditions for the reasons explained above. Therefore, it may be necessary to reduce the temperature of the plastic mass in the extruder by using a cooling operation or step immediately before discharging or ejecting the extrudate from the extruder. The temperature of the plastic mass may be reduced, in the extruder, for example, by using an extruder having an elongated nozzle or extension which communicates with the restricted die or orifice opening and from which the extrudate is ejected or discharged in the desired configuration (e.g., as an unpuffed, rod, ribbon or string) under atmospheric conditions. The plastic mass or flowable substance must be extruded or issued in uniform linear flow. The extension, for example, may be aircooled or may include a jacket through which cooling fluid (e.g., water) may be circulated.

In the event one wishes to produce a puffed product having a relatively coarse texture, relatively large cells, and which has more of a tendency to become soft when rehydrated, which properties may be acceptable for making snacks, then the translucent to glassy product may be puffed

in a separate and distinct operation without first being partly dried.

The grain or cell structure of the textured, puffed food product is related to the puffing conditions used in the moisture content of the translucent to glassy product. Since such textured food products will simulate or be used in or with a wide variety of foods, it is difficult to single out the "best" operating conditions. Generally, it has been found that finer cells result from the puffing operation when the translucent to glassy product to be puffed has a relatively low moisture content. The moisture content of the translucent to glassy product can be reduced to the desired moisture level of from 15 percent to 25 percent by weight by conventional means (e.g., air drying). One may partly dry the moisture-containing, translucent to glassy material, for example, with air at room temperature or hot circulating air at a temperature within the range of about 70°F. to 350°F., preferably within the range of about 130°F. to 250°F. Low heat is preferred, however, to prevent undesirable color and flavor changes.

The translucent to glassy product, regardless of whether or not it has been partly dried, has a continuous structure that resists the rapid or sudden release of moisture therefrom at elevated temperatures but, under water-boiling puffing conditions, allows for the build-up of pressure in the product from moisture which, when rapidly or suddenly released from the product under water-boiling puffing conditions (i.e., at water-boiling temperature), causes the product to puff or to be texturized.

The puffing step involves subjecting the moisture-containing, translucent to glassy product (regardless of whether or not it has been partly dried) to water-boiling condition by subjecting it to water-boiling temperature for from 15 to 75 seconds and at a pressure of from 150 psi to 250 psi and then suddenly releasing the pressure to cause puffing. The puffing operation expands the product (e.g., about two to ten-fold or more in volume as compared with the volume of the translucent to glassy product as it exists prior to puffing) and produces an expanded, structured, textured, porous product having cells formed by the sudden release of moisture. It is desirable to conduct the puffing step under conditions (e.g., moisture, time and temperature conditions) which obviate the development of undesired taste or flavor or discoloration. Furthermore, the puffing step should be conducted under conditions which cause substantially all of the translucent to glassy product to puff substantially uniformly.

One may, if desired, dry the puffed product to a desired residual moisture content. The puffed product, on contact with water, has good stability, is chewy, resists disintegration, and does not become soft and mushy. In addition, the puffed product can have a high bulk specific volume (e.g., at least about 4cc./gm.). The puffed product, on contact with boiling-water has the texture of natural meat and particularly poultry meat.

The following examples are provided in order to illustrate our invention.

Example 1 (Comparative)

100 parts by weight of gelatin is added to 100 parts by weight yellow corn flour and 100 parts by weight water. The moisture content of the mixture is about 35 percent by weight. The product is extruded using a laboratory Brabender (Registered Trade Mark) extruder with a 3 to 1 compaction screw which rotated at 95 rpm. The extruder has a heater barrel temperature of 130°C. and a die temperature of 165°C. The extruder has an air-cooled 8-inch pipe extension at the end of the extrusion barrel which has been flattened to eject the extrudate in the form of a ribbon about 1/2 inch wide and about 1/8 inch thick. The ejected non-puffed glassy product is air dried to a moisture content of about 15 percent by weight.

The partly dried glassy extrudate is puffed by placing it in a cereal puffing gun of the type described in U.S. Patent No. 1,878,782 and injecting live steam at about 395°F. and about 220 psi pressure for about 25 seconds. The puffing gun is suddenly opened to release the pressure and cause the product to puff. The puffed product is rehydrated by placing it in water and is found to closely resemble the texture of natural chicken meat.

Example 2

Example 1 is repeated except 4 parts by weight corn oil is added to the gelatin. The product is produced at a production rate of at least 20 percent greater than that of Example 1 and more nearly resembles meat texture than the product of Example 1.

Example 3

Example 2 is repeated except the protein material is egg white instead of gelatin. The color of this product is found to closely resemble meat and is superior to a product produced without the oil.

Example 4

Example 2 is repeated except the protein material is blood meal instead of gelatin. The color of this product is found to closely

resemble meat and is superior to a product produced without the oil.

Example 5

Example 2 is repeated except the corn oil is replaced with 1/2 percent by weight calcium stearate. The product has an excellent color and resembles meat and is produced at a rate at least 20 percent faster than in Example 1.

Example 6

Example 2 is repeated except the corn oil is replaced with 1 percent by weight glycerol. The product has an excellent color and resembles meat and is produced at a rate at least 20 percent faster than in Example 1.

Example 7

Example 2 is repeated except the corn oil is replaced with 1/2 percent by weight sodium stearoyl-2-lactylate. The product has an excellent color and resembles meat and is produced at a rate at least 20 percent faster than in Example 1.

Example 8

Example 2 is repeated except the corn oil was replaced with 10 parts by weight full fat soy flour (containing 18 percent by weight soybean oil). The product has an excellent color and resembles meat and is produced at a rate at least 20 percent faster than in Example 1.

Example 9

Example 2 is repeated except the live steam in injected into the puffing gun at a pressure of about 250 psi for about 17 seconds. Again, the color of the product is found to be very good.

In each of the examples produced by the method of this invention the product is free of "burned" color and taste and is far superior to any products ever produced without the oil added. Oils are normally to be very strictly avoided in extrusion of protein materials.

Reference is made under Section 9 to Patent Specifications Nos. 1,361,735 and 1,262,510. Reference is also made to our copending Applications Nos. 35012/73 and 35013/73 (Serial Nos. 1433842 & 1433843) which describe and claim related subject matter.

WHAT WE CLAIM IS:—

1. A process for preparing a puffed food product which upon rehydration produces a material simulating meat comprising: forming a proteinaceous mixture containing water, a protein material comprising a member selected from gelatin, microbiological protein, egg white, muscle protein, keratins, lactalbumin, or blood having a protein concentration of at least 30 percent by weight and 1/2 to 3 parts by weight of an edible lubricant per 100 parts by weight of non-fat solids; subjecting the mixture to shear and/or elevated pressure, and/or elevated temperature; extruding the flowable substance in a uniform linear flow into a medium of lower pressure to form an extrudate which does not simultaneously puff without texturisation; placing the extrudate in a confined space; subjecting the extrudate in the confined space in a temperature of at least 212°F for a time of from 15 to 75 seconds and a pressure of from 150 psi to 250 psi; and suddenly releasing the pressure on the extrudate causing the extrudate to puff and resemble meat and form a puffed food product having a moisture content of from 15 to 40 percent by weight.

2. A process as in claim 1 wherein the edible lubricant is present in an amount of 2 percent by weight.

3. A process as in claim 1 or 2 wherein the edible lubricant is a member selected from vegetable oil, animal oil or fat, oil bearing cereals, oil bearing grains, mineral oil food grade stearates or polylactic acid esters of fatty acids.

4. A process as in claim 1, 2 or 3 wherein the edible lubricant is corn oil or coconut oil.

5. A process as in any of the preceding claims wherein the protein has the pH adjusted to from 5.5 to 8.5.

6. A process as in any of the preceding claims wherein the moisture content of the extrudate is partially reduced without puffing prior to placing the extrudate in a confined space.

7. A process for preparing a puffed food product simulating meat substantially as herein described.

8. A puffed food product whenever obtained by the process of any one of the preceding claims.

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